Ultra-bright scintillator for planetary gamma ray spectroscopy

Completed Technology Project (2016 - 2019)

Project Introduction

Gamma ray spectroscopy (GRS) is an established method to determine the elemental composition of planetary surfaces and atmospheres. Orbital missions to planets and asteroids included gamma ray spectrometers as primary payload instruments. The compositional information has provided new information on a wide variety of geochemical and atmospheric processes. We expect that GRS will be used on many future missions. While GRS instrumentation for planetary science is mature, developments in other fields have rendered a portion of the technology obsolete. The technology gap is largest for scintillators, which fill a vital niche for planetary applications that require rugged, compact, low-power, low-cost sensors operated at ambient-temperature. To fill this gap, we will develop a gamma ray spectrometer based on strontium iodide (SrI2), a very bright, new scintillator. SrI2 will provide a factor of two to four times better energy resolution than scintillators with flight heritage. Measurement of many more elements will be enabled with better resolution, leading to improved geochemical characterization. Large, single crystals of SrI2 can be grown, simplifying implementation compared to arrays envisioned for other sensor technologies (CdZnTe). Low cost, high energy resolution, solid-state read out, absence of self-activity, and the potential for size scalability make SrI2 the best choice amongst competing scintillators (vs. CeBr3 and LaBr3). The development of compact, modular sensors based on SrI2 will be explored using a systems engineering approach. Modeling, validated by experiment, will be used to assess the performance of SrI2 relative to other sensor concepts for mission scenarios envisioned in the decadal survey. This effort will guide instrument design and accommodation on representative platforms (CubeSats, orbiters, atmospheric probes, landers, and rovers). Approaches to grow crystals large enough to meet measurement requirements will be investigated. Packaging, read out, and digital pulse processing electronics for SrI2 will be developed. Various read-out methods, including commercial solid state alternatives for photomultiplier tubes, will be evaluated. Radiation damage effects, response to particles found in the space environment, and induced radiation backgrounds will be characterized by laboratory/accelerator experiments and modeling. The instrument concept enters at Technology Readiness Level (TRL) 3 and will be at TRL-4 or higher by the end of the project. The technology will be used for Discovery missions to targets small and large in the inner and outer solar system. GRS can provide landing-site geochemical context for New Frontiers sample return missions to a comet and the lunar South Pole-Aitken basin. GRS can also obtain chemical data during flybys, in orbit and in situ for a Trojan Tour and Rendezvous mission. Including a SrI2 GRS on the Venus In Situ Explorer would significantly improve existing measurements of K/Th.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Planetary Instrument Concepts for the Advancement of Solar System Observations

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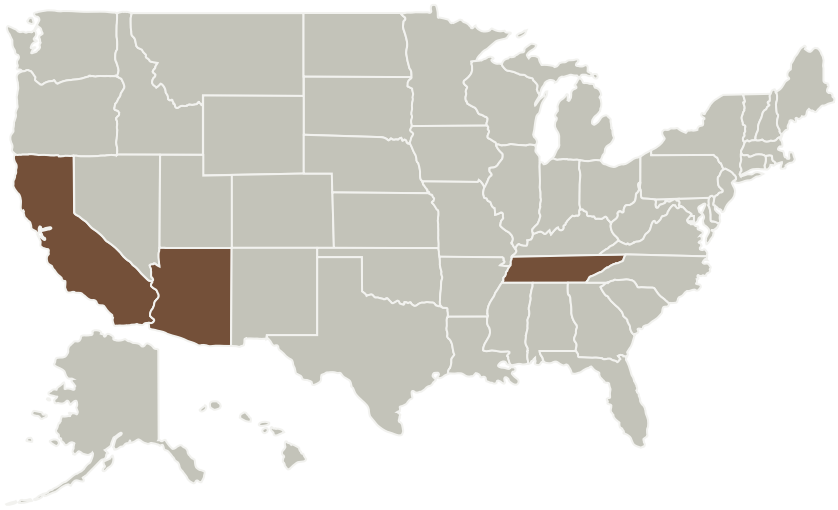
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Planetary Science Institute(PSI)	Supporting Organization	Industry	Tucson, Arizona

Primary U.S. Work Locations	
Arizona	California
Tennessee	

Project Management

Program Director:
Carolyn R Mercer

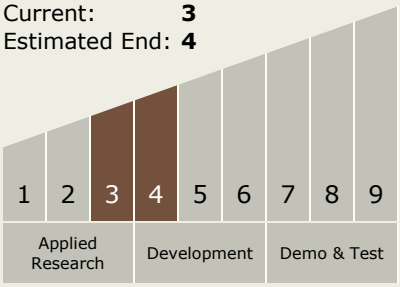
Program Manager:
Haris Riris

Principal Investigator:
Thomas H Prettyman

Co-Investigators:
Julie C Castillo
Naoyuki Yamashita
Elaine Owens
Arnold Burger
Keivan G Stassun
James L Lambert

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors

Continued on following page.

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Technology Areas *(cont.)*

- TX08.1.1 Detectors and Focal Planes

Target Destination

Others Inside the Solar System